

IGCSE Biology Edexcel

Characteristics of Living Organisms

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YOUR NOTES



1.1 Characteristics of Living Organisms

YOUR NOTES



The Unifying Characteristics of Living Organisms

- In order for something to be considered 'living', it must fulfil specific criteria that are true of all living organisms
- These criteria can be remembered using the acronym MRS C GREN
 - Movement
 - Respiration
 - Sensitivity
 - Control
 - Growth
 - Reproduction
 - Excretion
 - Nutrition
- If something does not carry out all of these life processes, it is either dead or non-living
- Viruses are a good example of non-living particles/agents

Nutrition

- Organisms must obtain food to provide **energy**
 - Energy is necessary to carry out life processes e.g. movement, respiration and excretion

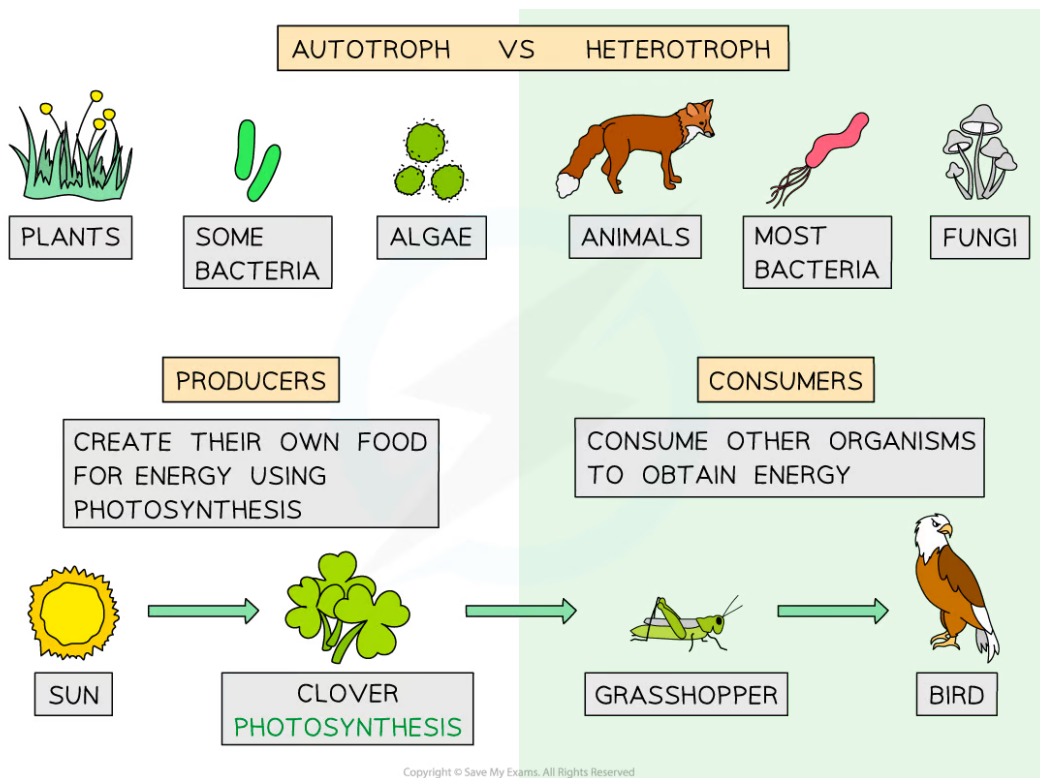
Nutrition in plants

- Plants use **sunlight**, **carbon dioxide** and **water** to produce **oxygen** and **glucose** in the process of **photosynthesis**
- Because plants **create their own food for energy**, they are described as being **autotrophic**

Nutrition in animals

- Animals consume other **living organisms** in order to obtain the **energy** they require
- They break down larger complex molecules into simpler molecules through the process of **digestion**
- As animals obtain their food from a **range of different sources**, they are described as being **heterotrophic**

YOUR NOTES



[Use this image](#)

Autotrophs make their own food whereas heterotrophs obtain it from a range of food sources.



Exam Tip

Sometimes understanding the origin of a word can help us to remember the meaning, for example: Autotroph comes from:

- 'auto' = 'self'
- 'trophic' = 'feeding'

Heterotroph comes from:

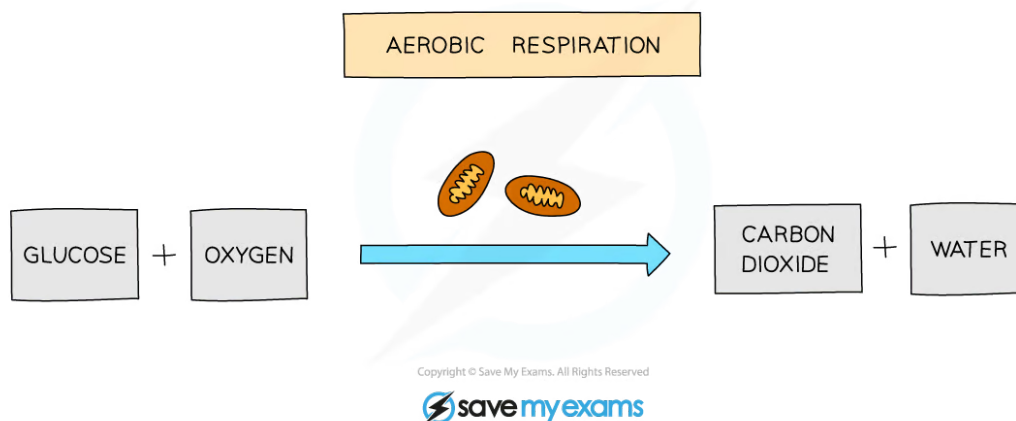
- 'hetero' = 'different'
- 'trophic' = 'feeding'

YOUR NOTES



Respiration

- **Respiration** is a **chemical reaction** carried out in **all** living organisms
- **Energy** is released from **glucose** either in the presence of oxygen (aerobic respiration) or the absence of oxygen (anaerobic respiration)
- The reactions ultimately result in the production of **carbon dioxide** and **water** as waste products
- Energy is transferred in the form of **ATP**



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The equation for aerobic respiration



Exam Tip

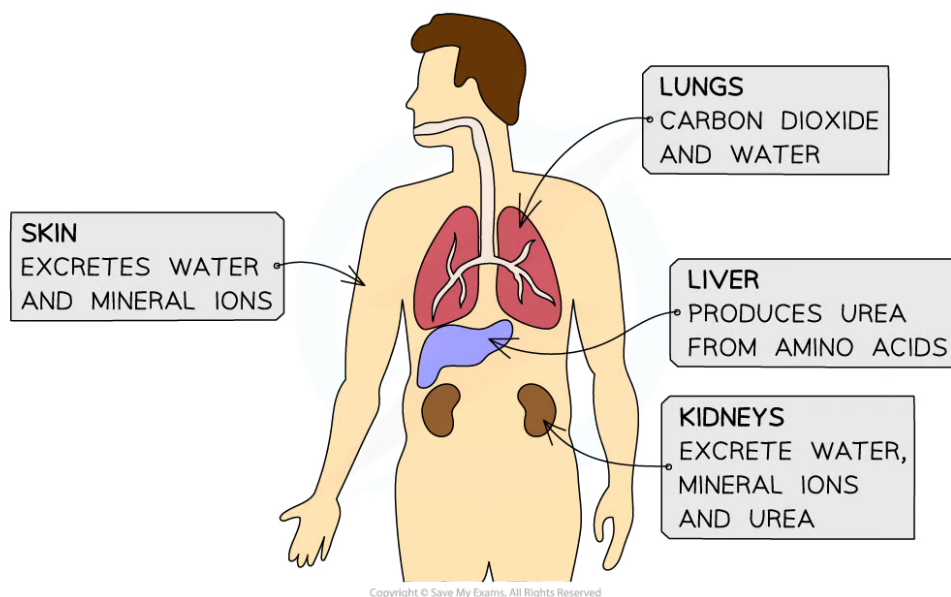
Make sure not to confuse respiration with gas exchange. Gas exchange involves getting oxygen into the cells and carbon dioxide out. Respiration uses the oxygen supplied from gas exchange to release energy in the form of **ATP**.

Excretion

- **Chemical reactions** that take place inside living cells are described as **metabolic reactions**
- Metabolic reactions produce waste products, some of which may be **toxic**
- These toxic products must be **eliminated** from the body
- Excretion is the **removal of toxic materials and substances** from organisms

Excretion in animals

- Waste products excreted by **animals** include:
 - **Carbon dioxide** from **respiration**
 - **Water** from **respiration** and other chemical reactions
 - **Urea** which contains **nitrogen** resulting from the breakdown of **proteins**



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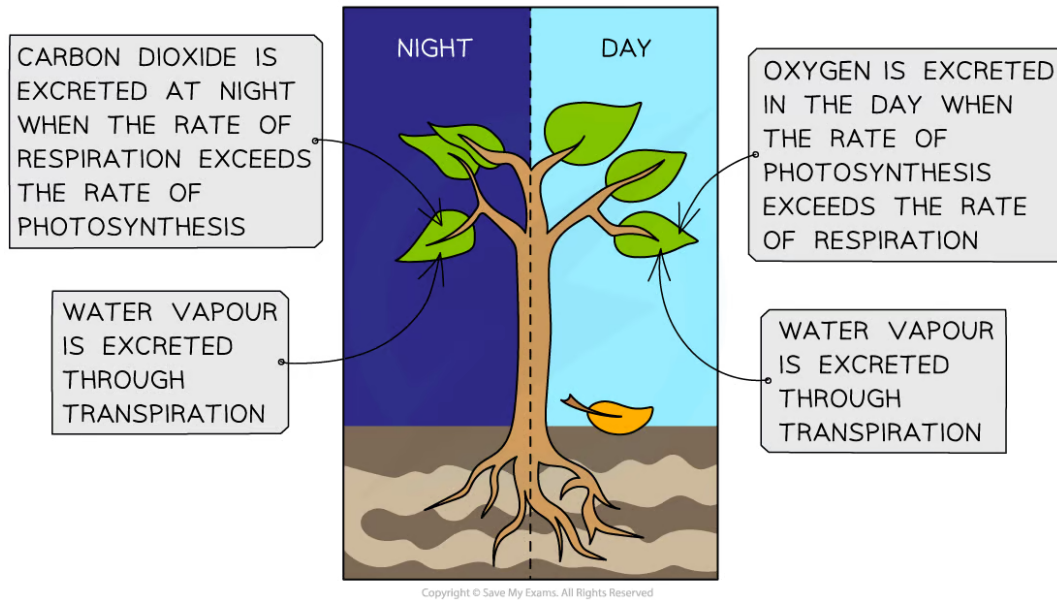
Excretion in humans, the waste products and organs involved.

Excretion in plants

- Waste products excreted by **plants** include:
 - **Oxygen** from **photosynthesis**
 - **Carbon dioxide** from **respiration**
 - **Water** from **respiration** and other chemical reactions

YOUR NOTES





[Use this image](#)

Excretion in plants, the waste products and the difference between day and night.



Exam Tip

Excretion is often confused with **egestion**. Remember that the waste products removed through excretion have originated from **chemical reactions in the cells**. However, the waste products produced in egestion are in the form of **faeces** and originate from the remains of the **substances not absorbed during digestion**.

YOUR NOTES

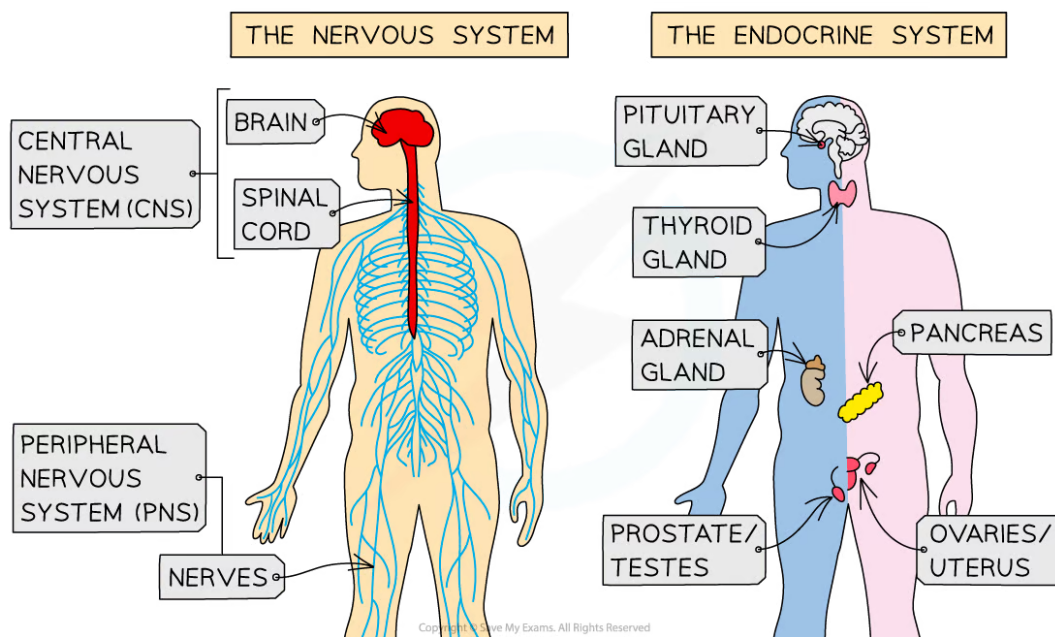


Response to Surroundings

- The **sensitivity** of an organism refers to its ability to detect and **respond** to **stimuli** in its **surroundings**
- Responding to the environment around them gives an organism the best **chances of survival**

Sensitivity responses in animals

- In humans, **the nervous system** provides a complex system of **receptors**, **neurones** and **effectors** which detect and respond to different stimuli using **electrical impulses**
- The **endocrine system** also allows a response to stimuli using chemical messengers, which travel in the **blood**, called **hormones**



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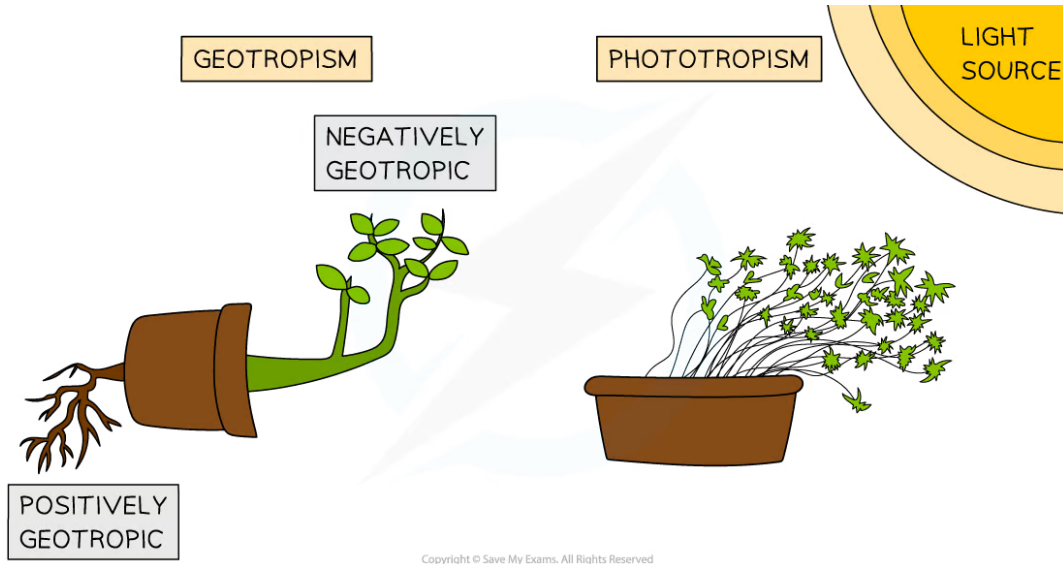
The nervous system and endocrine system allow humans to respond to their environment.

Sensitivity responses in plants

- In plants, responses are controlled by **chemicals** and are usually much **slower**
 - **Geotropism** describes a plant's response to **gravity** which causes the roots to grow down into the soil
 - **Phototropism** describes a plant's response to **light** which causes shoots to grow towards sunlight

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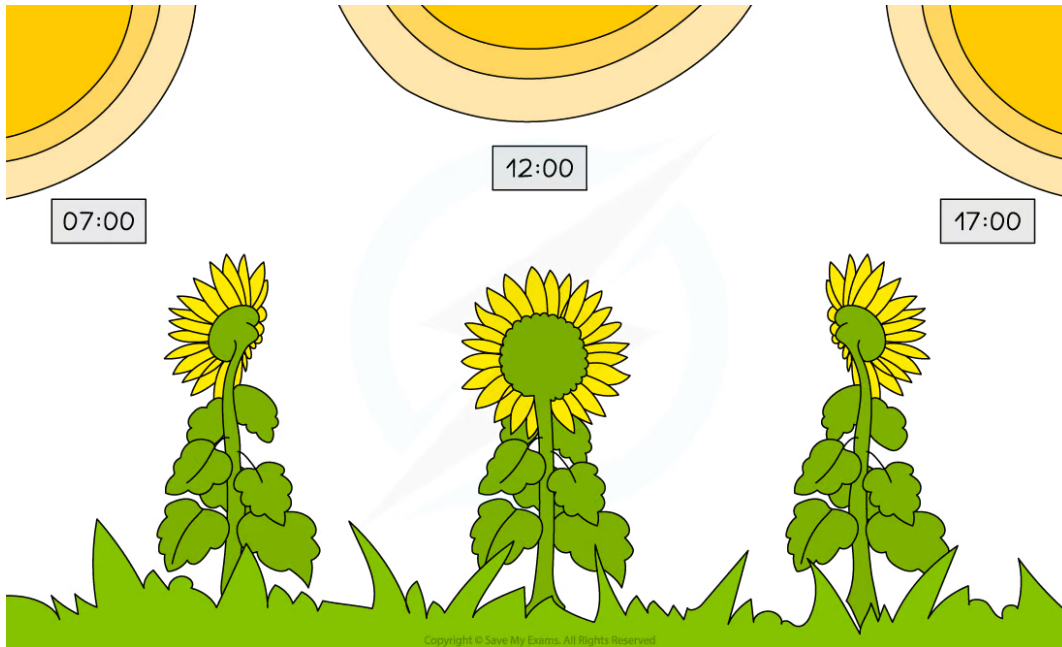
Phototropism and geotropism allow plants to respond to their environment.

YOUR NOTES



Movement

- Movement is an **action by an organism** causing a **change of position or place**
- The movement of an organism from place to place is called **locomotion**
- Plants cannot move from place to place but can change their **orientation**
 - For example, sunflowers track the sun and so change their orientation throughout the day



[Use this image](#)

Sunflowers track the sun throughout the day.

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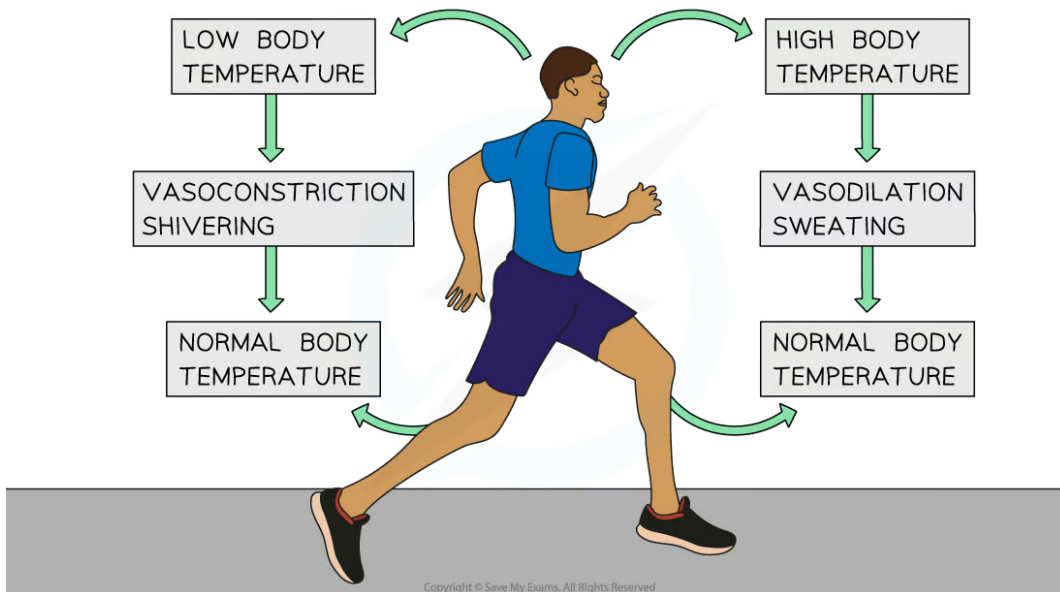


Control

- Living organisms must control their internal environment in order to keep conditions within **required limits**
- This is called **homeostasis**

Homeostasis in humans

- Thermoregulation refers to the control of body temperature
- **The optimum** human body temperature is **37°C**
 - If body temperature **increases** e.g. during exercise, mechanisms for control will be initiated to **return the temperature** back to the optimum
 - Mechanisms include **sweating or vasodilation**
- Other homeostatic mechanisms in humans include **glucoregulation** (control of blood glucose levels) and **osmoregulation** (control of water levels)



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Thermoregulation is an example of homeostasis required to maintain a body temperature of 37°C.

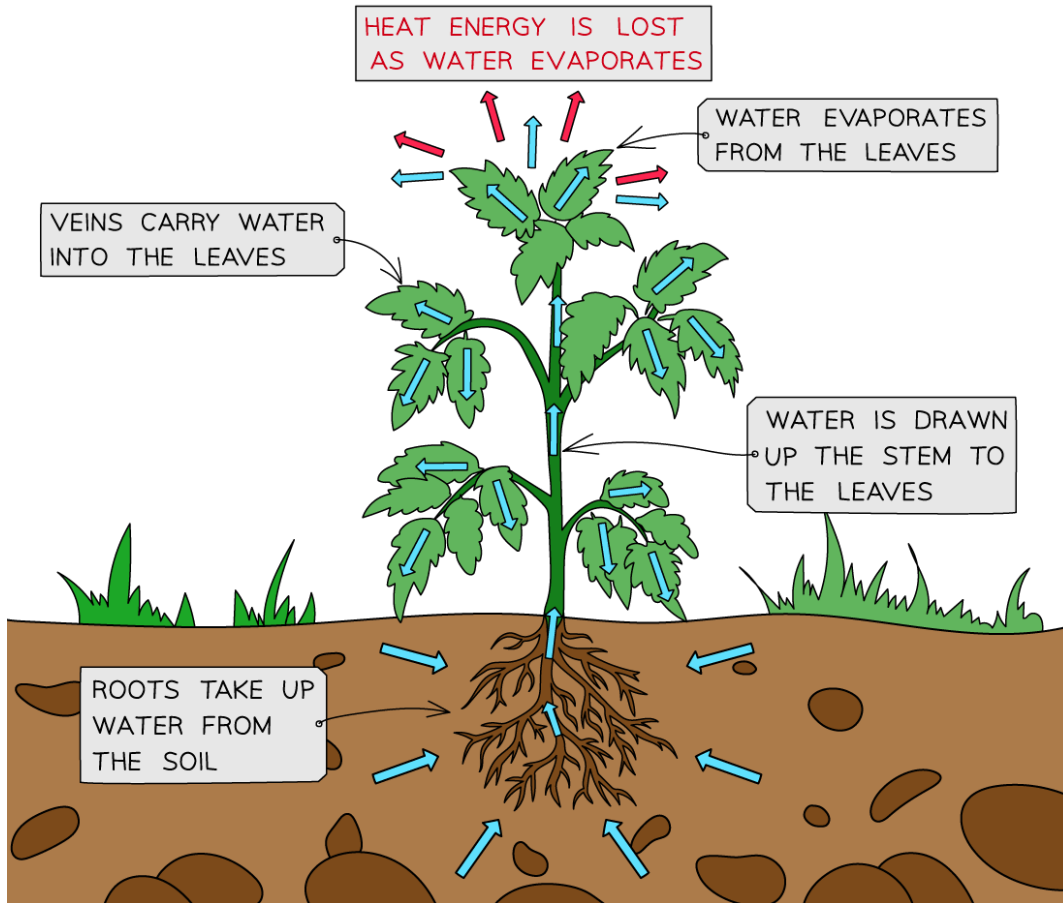
Homeostasis in plants

- Plants use **transpiration** to maintain a suitable **temperature**
- Water **evaporates** from the **stomata** on the underside of the leaf, leading to **heat loss**

YOUR NOTES



YOUR NOTES



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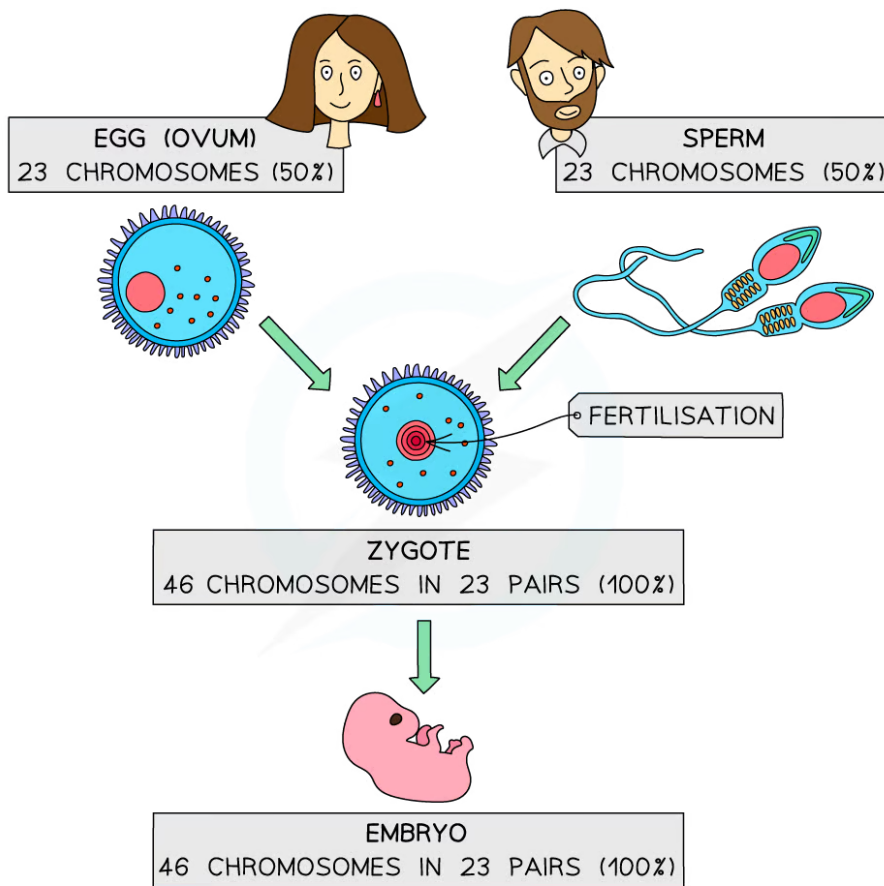
Plants maintain an optimum temperature through transpiration

Reproduction

- **Reproduction** is the process that leads to the **production of more of the same kind of organism**
- Reproduction is fundamental to the **survival** of a population and ultimately, the species
- There are different types of reproduction: sexual and asexual

Sexual Reproduction

- In this type of reproduction, the male and female **gametes fuse together**
 - In humans, the male gamete is the **sperm** and the female gamete is the **egg**
 - In plants, the male gamete is in the **pollen** grains and the female gamete is the **ovule**
- The DNA of the offspring is composed of both **maternal** and **paternal** DNA



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Sexual reproduction involves the fusing of two gametes to form a zygote that contains DNA from both parents.

Asexual reproduction

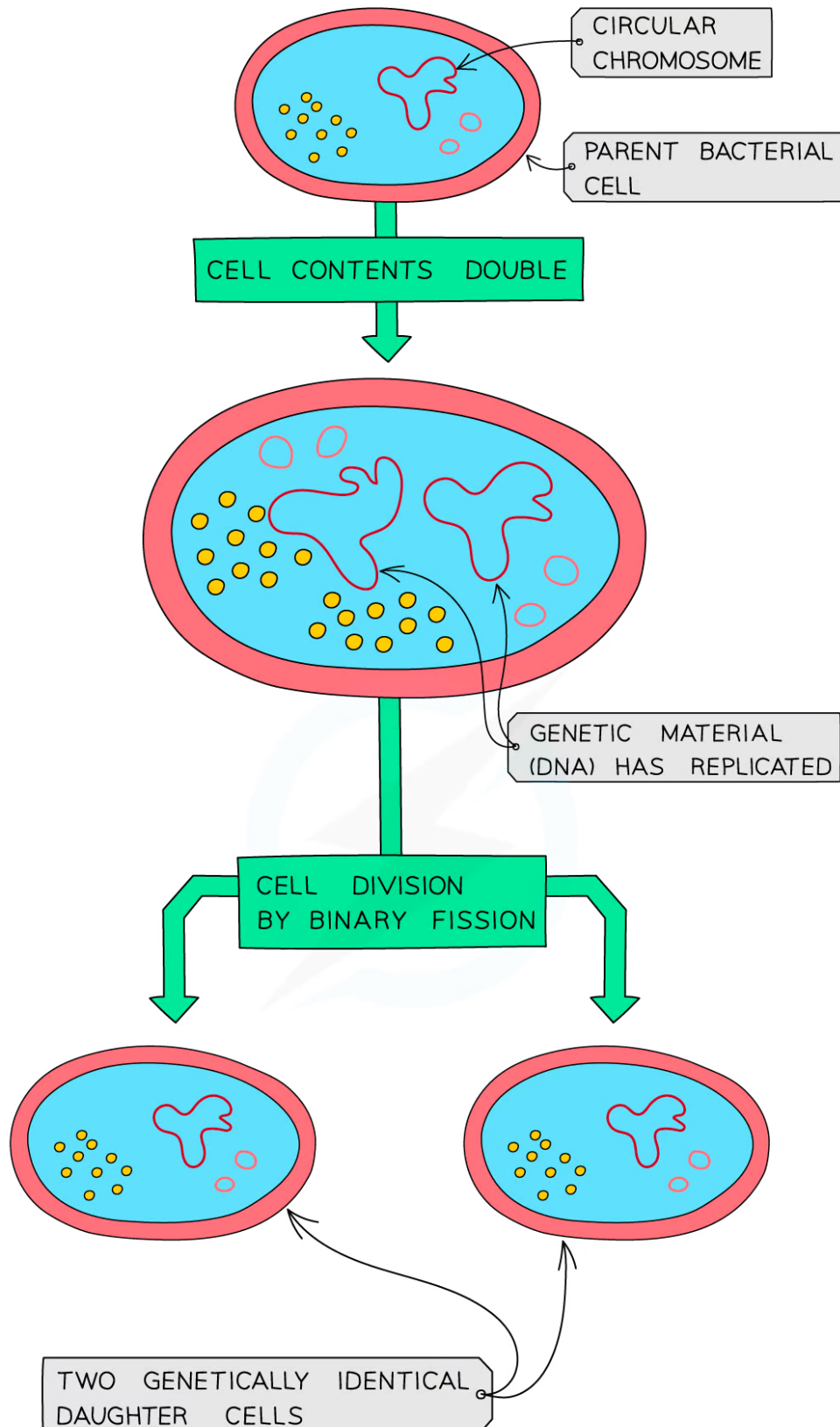
- Cells or whole organisms can also reproduce using **asexual reproduction**
- **Mitosis** is an example of asexual reproduction
- There is only **one parent** involved so an exact **clone** is produced
- The DNA of offspring is **identical** to parental DNA
 - Plants can reproduce asexually through **tubers**, **budding** or **runners**

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- Single-celled organisms such as **bacteria** or **amoeba** reproduce asexually

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Asexual reproduction in bacteria involves creating exact copies of the parent cell.

Growth

- **Growth** is defined as a **permanent increase in size**
- In **animals**, an individual grows larger between the zygote and **adult** stage with **changes in proportion or shape**
- In **plants**, an individual grows **larger throughout their whole life** with **new** shoots, leaves, branches etc forming year after year

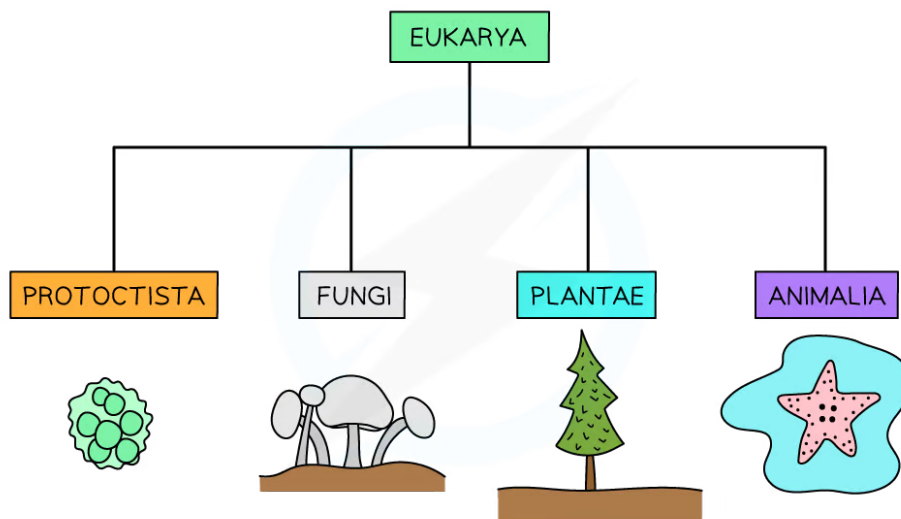
1.2 Common Features: Eukaryotic Organisms

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Common Features of Eukaryotic Organisms: Basics

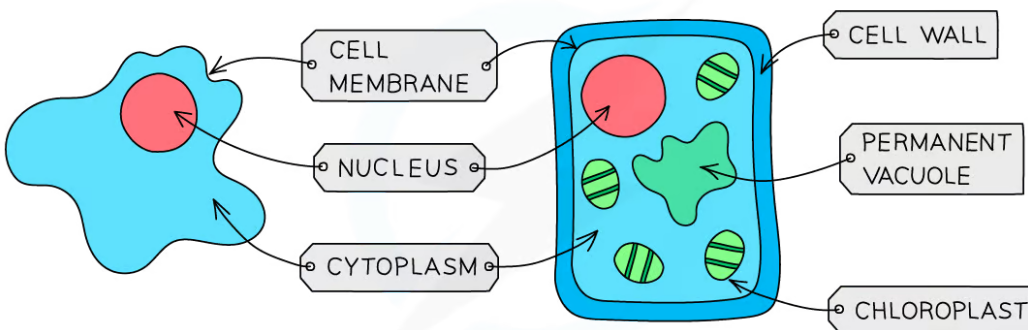
- All living organisms can be grouped or 'classified' using a classification system that consists of **five kingdoms**. These five kingdoms are:
 - Animals
 - Plants
 - Fungi
 - Protoctists
 - Prokaryotes
- The first four kingdoms in this list (the animals, plants, fungi and protoctists) can actually be **grouped together**, as they are all **eukaryotic organisms** (also known as **eukaryotes**)



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Animals, plants, fungi and protoctists are all eukaryotes.

- Eukaryotic organisms can be **multicellular or single-celled** and are made up of cells that contain a **nucleus** with a **distinct membrane**



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An animal cell (left) and plant cell (right) as seen under a light microscope. They are both eukaryotic cells as they both have a distinct membrane-bound nucleus.

- **Prokaryotic organisms** (also known as **prokaryotes**) are in a **separate kingdom** and are **different** from eukaryotes as they are **always single-celled** and **do not contain a nucleus** (instead, the **nuclear material** of prokaryotic cells is found in the **cytoplasm**)
 - **Bacteria** are prokaryotic organisms
- Prokaryotic cells are substantially **smaller** than eukaryotic cells

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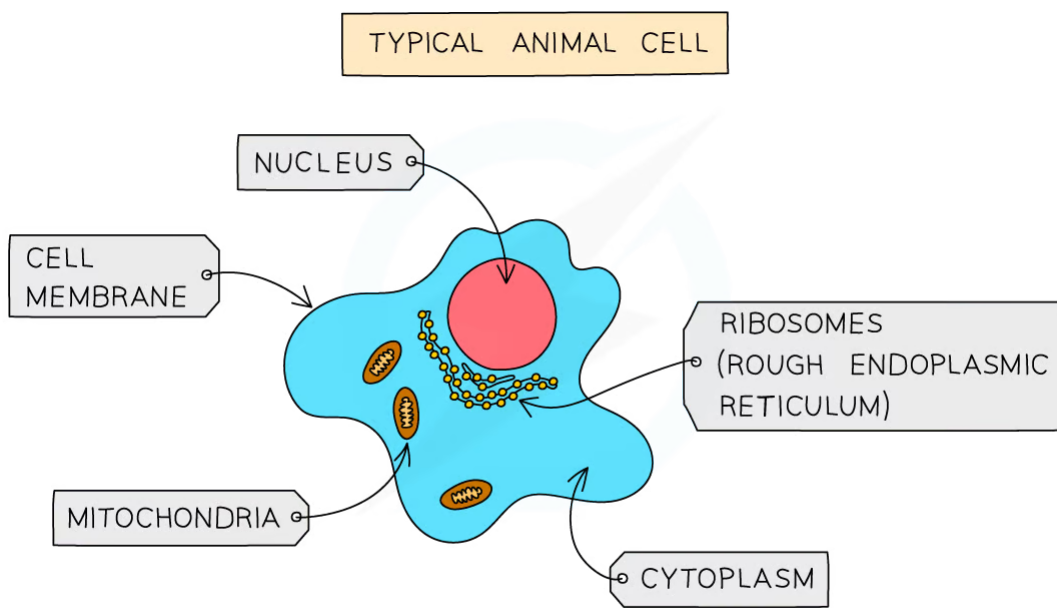
Animals

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- The main features of animals:

- They are **multicellular**
- Their cells contain a **nucleus** with a **distinct membrane**
- Their cells **do not** have **cellulose cell walls**
- Their cells **do not** contain **chloroplasts** (so they are **unable** to carry out **photosynthesis**)
- They feed on organic substances made by other living things
- They often store carbohydrates as **glycogen**
- They usually have **nervous coordination**
- They are able to **move** from place to place



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A typical animal cell

Cell Structures Found in Both Animal and Plant Cells Table

STRUCTURE	FUNCTION
NUCLEUS	CONTAINS THE GENETIC MATERIAL (DNA) WHICH CONTROLS THE ACTIVITIES OF THE CELL
CYTOPLASM	- A GEL –LIKE SUBSTANCE COMPOSED OF WATER AND DISSOLVED SOLUTES - SUPPORTS INTERNAL CELL STRUCTURES - SITE OF MANY CHEMICAL REACTIONS, INCLUDING ANAEROBIC RESPIRATION
CELL MEMBRANE	- HOLDS THE CELL TOGETHER, SEPARATING THE INSIDE OF THE CELL FROM THE OUTSIDE - CONTROLS WHICH SUBSTANCE CAN ENTER AND LEAVE THE CELL
RIBOSOMES	- FOUND IN THE CYTOPLASM - SITE OF PROTEIN SYNTHESIS
MITOCHONDRIA	- SITE OF MOST OF THE REACTIONS INVOLVED IN AEROBIC RESPIRATION, WHERE ENERGY IS RELEASED TO FUEL CELLULAR PROCESSES - CELLS WITH HIGH RATES OF METABOLISM (CARRYING OUT MANY DIFFERENT CELL REACTIONS) HAVE SIGNIFICANTLY HIGHER NUMBERS OF MITOCHONDRIA THAN CELLS WITH FEWER REACTIONS TAKING PLACE

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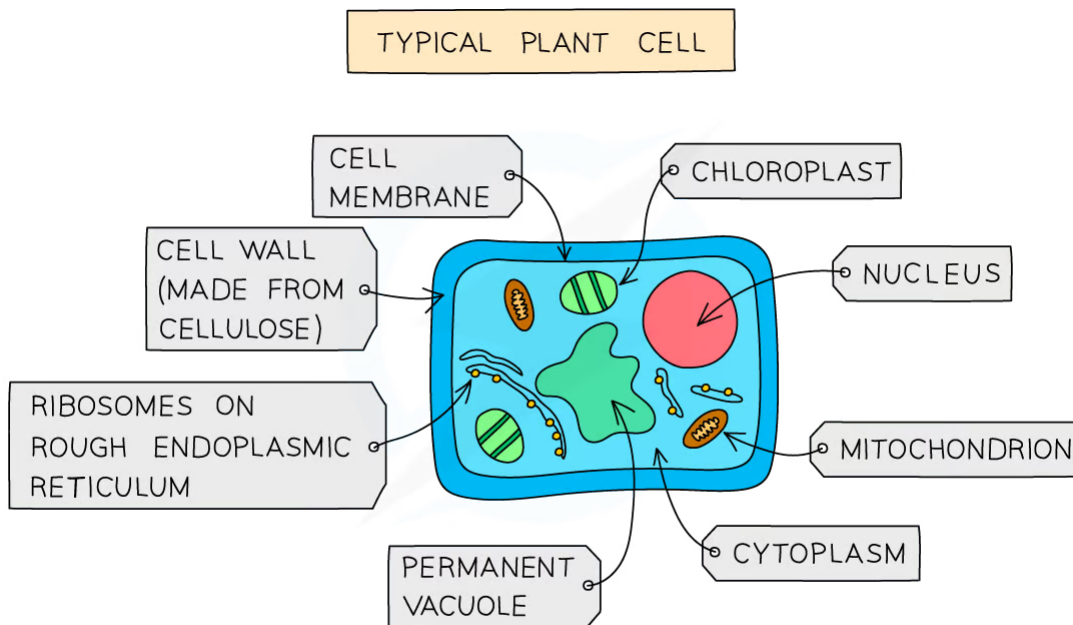
Plants

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- The main features of plants:

- They are **multicellular**
- Their cells contain a **nucleus** with a **distinct membrane**
- Their cells have **cell walls** made out of **cellulose**
- Their cells contain **chloroplasts** (so they can carry out **photosynthesis**)
- They feed by **photosynthesis**
- They store carbohydrates as **starch** or **sucrose**
- They **do not** have nervous coordination



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A typical plant cell

Cell Structures Found Only in Plant Cells Table

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STRUCTURE	FUNCTION
CELL WALL	• MADE OF CELLULOSE (A POLYMER OF GLUCOSE) • GIVES THE CELL EXTRA SUPPORT, DEFINING ITS SHAPE
CHLOROPLASTS	• CONTAINS GREEN CHLOROPHYLL PIGMENTS (TO ABSORB LIGHT ENERGY) AND THE ENZYMES NEEDED FOR PHOTOSYNTHESIS
A PERMANENT VACUOLE	• CONTAINS CELL SAP; A SOLUTION OF SUGARS AND SALTS DISSOLVED IN WATER • USED FOR STORAGE OF CERTAIN MATERIALS • ALSO HELPS SUPPORT THE SHAPE OF THE CELL

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**Exam Tip**

You need to be able to recognise, draw and interpret images of cells, so practice drawing and labelling animal and plant cells as part of your revision.

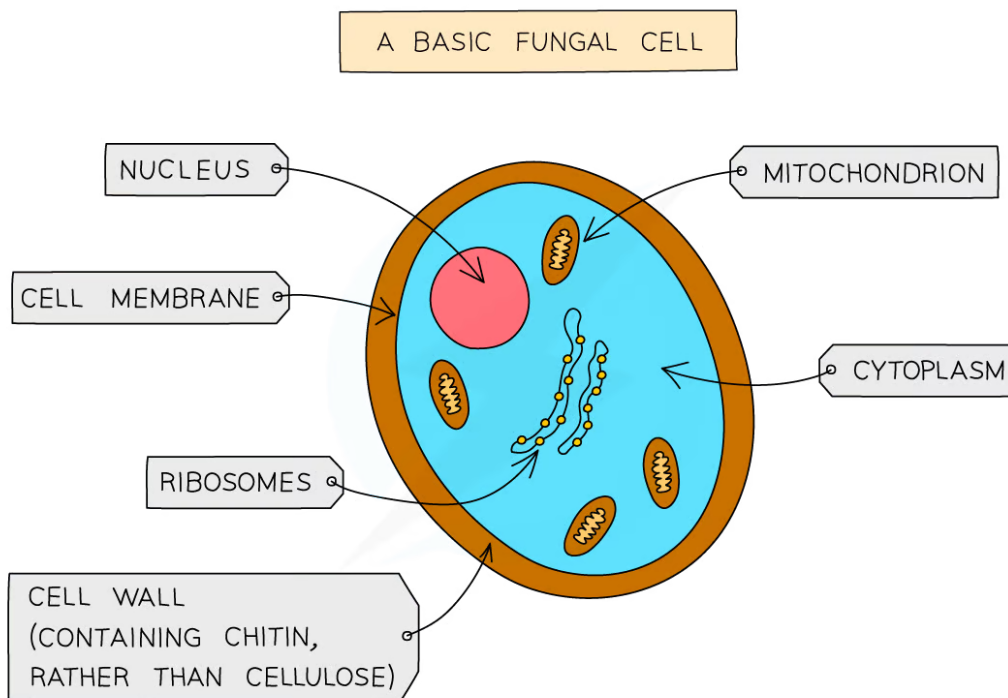
Fungi

YOUR NOTES



- **Main features of fungi:**

- They are **usually multicellular** but some are **single-celled** (e.g. yeast)
- Multicellular fungi are mainly made up of **thread-like structures** known as **hyphae** that contain **many nuclei** and are organised into a **network** known as a **mycelium**
- Their cells contain a **nucleus** with a **distinct membrane**
- Their cells have cell walls made of **chitin** (chitinous cell walls)
- Their cells **do not** contain **chloroplasts** (so they **cannot** carry out **photosynthesis**)
- They feed by **secreting extracellular digestive enzymes** (outside the mycelium) **onto the food** (usually decaying organic matter) and then absorbing the digested molecules. This method of feeding is known as **saprotrophic nutrition**
- Some fungi are **parasitic** and feed on **living material**
- Some fungi store carbohydrates as **glycogen**
- They **do not** have **nervous coordination**
- Examples of fungi include: moulds, mushrooms, yeasts

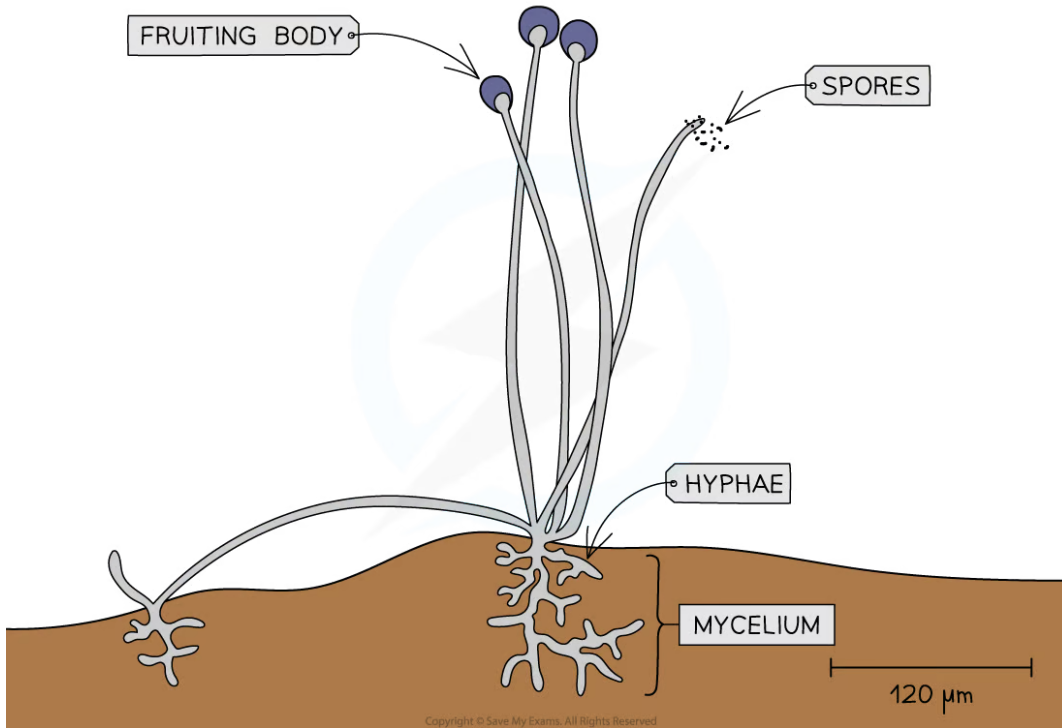


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A typical fungal cell.

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The typical structure of a multicellular fungus e.g. Mucor (bread mould).

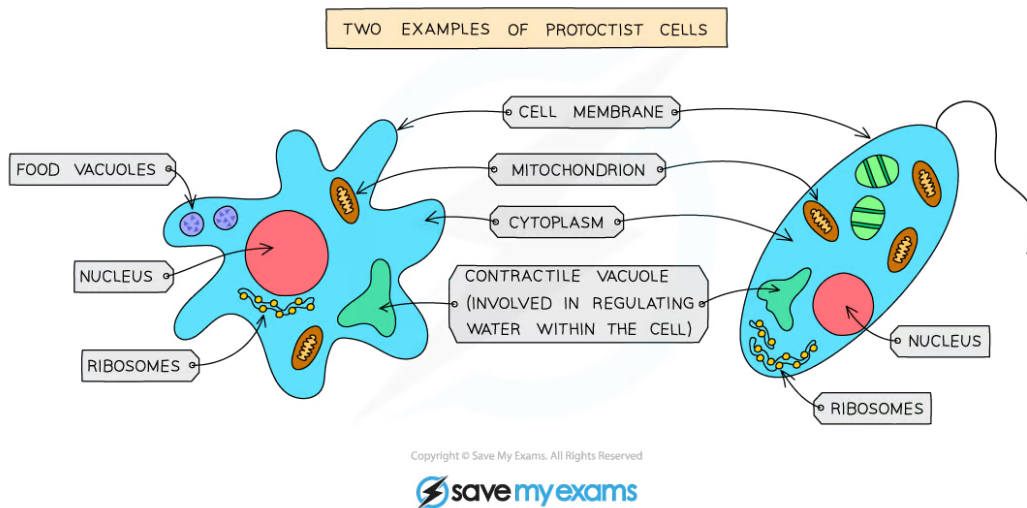
Protoctists

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• Main features of protoctists:

- The protoctists are a very **diverse** kingdom of organisms that don't really belong in any of the other eukaryotic kingdoms (animals, plants and fungi)
- They are **mainly microscopic and single-celled** but some **aggregate** (group together) into **larger forms**, such as colonies or chains of cells that form filaments
- Their cells contain a **nucleus** with a **distinct membrane**
- Some have features making them more like animal cells e.g. ***Plasmodium*** (the protoctist that causes **malaria**)
- Some have features, such as **cell walls** and **chloroplasts**, making them more like plant cells e.g. **green algae**, such as ***Chlorella***
- This means **some** protoctists **photosynthesise** and some feed on organic substances made by other living things
- They **do not** have **nervous coordination**
- Examples of protoctists include: amoeba, *Paramecium*, *Plasmodium*, *Chlorella*



Two examples of protoctist cells



Exam Tip

You need to be able to recognise, draw and interpret images of cells, so practice drawing and labelling fungal cells and protoctist cells as part of your revision.

1.3 Common Features: Prokaryotic Organisms

YOUR NOTES

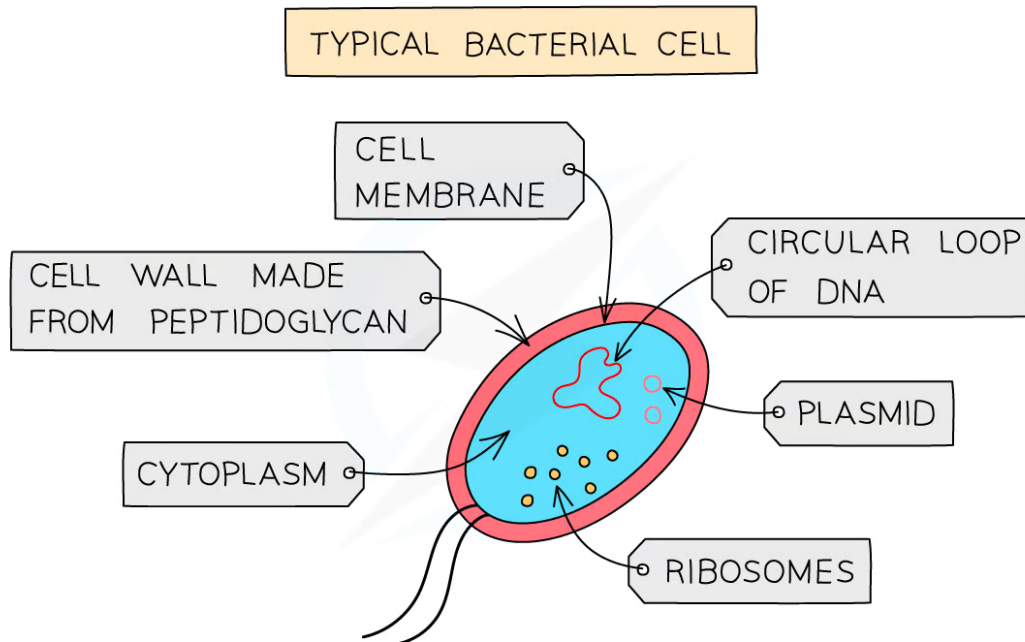


Prokaryotes

- All living organisms can be grouped or 'classified' using a classification system that consists of **five kingdoms**. These five kingdoms are:
 - **Animals**
 - **Plants**
 - **Fungi**
 - **Protoctists**
 - **Prokaryotes**
- The **prokaryotes** are **different** from the other four kingdoms (which are all eukaryotes) as prokaryotic organisms are **always single-celled** and **do not contain a nucleus**
- Instead, the **nuclear material** of prokaryotic cells is found in the **cytoplasm**
- **Bacteria** are prokaryotic organisms

Bacteria

- Bacteria, which have a wide variety of shapes and sizes, all share the following biological characteristics:
 - They are **microscopic single-celled organisms**
 - They have a **cell wall** (**not** made of **cellulose**), **cell membrane**, **cytoplasm** and **plasmids**
 - They **lack a nucleus** but contain a **circular chromosome of DNA**
 - They **lack mitochondria and other membrane-bound organelles** found in eukaryotic cells
- Examples of bacteria include:
 - **Lactobacillus** (a rod-shaped bacterium used in the production of yoghurt from milk)
 - **Pneumococcus** (a spherical bacterium that acts as the pathogen causing pneumonia)
- Bacteria **feed in different ways**:
 - Some bacteria can carry out **photosynthesis** despite having no chloroplasts. This is because they still possess **chlorophyll** and **enzymes** necessary to synthesize sugars from carbon dioxide.
 - Most feed on other **living or dead organisms** (if they feed on **dead organic matter** then they are known as **saprobionts** or **decomposers**)



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A typical bacterial cell

Prokaryotic Cells Table

COMPONENT	EUKARYOTES	PROKARYOTES
CELL MEMBRANE	Y	Y
CYTOPLASM	Y	Y
GENETIC MATERIAL	Y – IN A NUCLEUS	Y – IN THE CYTOPLASM
NUCLEUS	Y	N
CELL WALL	SOME TYPES	Y – MADE FROM PEPTIDOGLYCAN

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1.4 Pathogens

YOUR NOTES



Types of Pathogen

- A **pathogen** is any microorganism that **causes disease** in another organism (e.g. in plants or animals)
- Many **microorganisms** are pathogens including:
 - **Bacteria**
 - **Fungi**
 - **Protoctists**
 - **Viruses**
- **Not all species** within these groups (apart from the viruses) are pathogens, as many bacteria, fungi and protoctists are **harmless** and **do not cause disease**
- However, **all viruses are pathogenic** as they can **only exist** by living inside the living cells of other organisms (or by using these cells to create more viruses)

Pathogenic bacteria

- Pathogenic bacteria do not always infect the hosts of cells, they can remain within body cavities or spaces
- *M. tuberculosis* causes **tuberculosis** (TB) in humans
 - The bacteria infect the lungs, causing a chronic cough and bloody mucus
 - It is a disease often associated with poor hygiene and sanitation
 - *M. bovine* in cows can also transmit to humans to cause TB
- *N. meningitidis* causes **bacterial meningitis** in humans
 - Very few bacteria can cross the barrier created by the meninges (the tissue that surrounds the brain and spinal cord) however *N. meningitidis* crosses this barrier to cause acute inflammation
 - Inflammation of the meninges causes symptoms such as fever, headache, neck stiffness and a characteristic rash

Pathogenic fungi

- Fungal diseases are much more common in plants than animals
- **Cattle ringworm** and **athletes foot** are fungal diseases that exist on the surface of the skin
- Fungal diseases in plants tend to be much more serious and can threaten entire crops
- **Black Sigatoka** is a fungal disease in bananas
 - It spreads through the leaves of the plant, reducing its ability to photosynthesise
 - The lack of photosynthesis causes parts of the leaf to die; producing black streaks
 - Eventually, the whole leaf dies

Pathogenic protoctists

- *Plasmodium falciparum* is a protist that causes severe forms of **malaria** in humans
 - The parasite is spread by mosquitoes
 - Infected individuals experience fever, chills and fatigue
- *P. infestans* causes the infamous **potato blight**
 - The pathogen is unusual as it has some fungal characteristics
 - It is transmitted via spores

- The first signs of potato blight are small, dark brown marks on the leaves which quickly increase in size and number
- The protist destroys potato and tomato crops leaving them completely inedible

YOUR NOTES

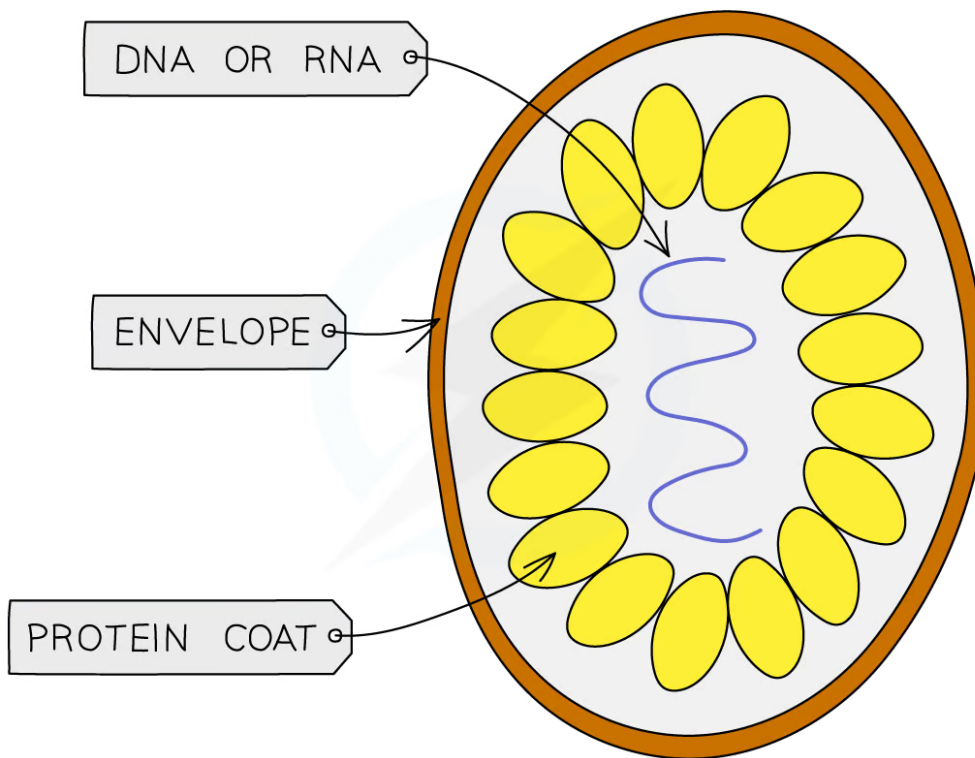


Viruses

YOUR NOTES



- **Viruses** are not usually included in the classification of living organisms as they are **not considered to be alive**
 - This is due to the fact that viruses **do not carry out the 8 life processes** for themselves
- In fact, the only life process they seem to display is reproduction but even to carry out this process they must **take over a host cell's metabolic pathways** in order to make multiple copies of themselves
- Viruses, which have a wide variety of shapes and sizes, all share the following biological characteristics:
 - They are small particles (**always smaller than bacteria**)
 - They are parasitic and **can only reproduce inside living cells**
 - They infect **every type of living organism**
 - They have **no cellular structure** but have a **protein coat** and contain one type of **nucleic acid**, either **DNA** or **RNA**



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Structure of a typical virus

- Examples of viruses include:

- The **tobacco mosaic virus** (TMV) causes discolouring of the leaves on tobacco plants by preventing the formation of chloroplasts
- The **HIV virus** causes **AIDS**
- The **influenza virus** causes the 'flu'

YOUR NOTES



Tobacco mosaic virus

- Tobacco mosaic virus (TMV) was the first virus to be isolated by scientists
- It is a widespread plant pathogen that infects about 150 species of plants including tomato plants and cucumbers

TMV Table

SYMPTOMS	HOW IS IT SPREAD?
• THE SYMPTOMS OF TOBACCO MOSAIC VIRUS ARE THE DISTINCTIVE MOSAIC PATTERN OF DISCOLOURATION OF THE LEAVES AS THE VIRUS INFECTS THE CHLOROPLASTS • THE PLANT WILL NOT GROW AS MUCH DUE TO THE LACK OF PHOTOSYNTHESIS – THIS REDUCES THE YIELD OF CROPS	• THE VIRUS IS SPREAD BY: ◦ PLANTS IN DIRECT CONTACT WITH AN INFECTED PLANT ◦ THE VIRUS CAN STAY IN THE SOIL FOR ABOUT 50 YEARS
TREATMENT & PREVENTION	
• THERE IS NO TREATMENT FOR TOBACCO MOSAIC VIRUS AND THE BEST METHOD OF CONTROL IS GOOD FIELD HYGIENE TO PREVENT THE SPREAD OF THE VIRUS. FARMERS ARE ALSO USING TOBACCO MOSAIC VIRUS-RESISTANT STRAINS OF CROP PLANTS	

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HIV

- HIV (Human Immunodeficiency Virus) is a virus that can eventually lead to Acquired Immunodeficiency Syndrome (**AIDS**)

HIV Table

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SYMPTOMS	HOW IS IT SPREAD?
• HIV STARTS WITH A FLU-LIKE ILLNESS • IF UNTREATED IT CAN TRAVEL TO THE LYMPH NODES AND ATTACK CELLS OF THE IMMUNE SYSTEM • IT CAN STAY HIDDEN IN THE IMMUNE SYSTEM FOR MANY YEARS UNTIL THE IMMUNE SYSTEM IS SO BADLY DAMAGED IT CAN NO LONGER DEAL WITH OTHER INFECTIONS OR CANCERS (THIS IS LATE-STAGE HIV INFECTION, KNOWN AS AIDS)	• THE VIRUS IS SPREAD BY: ◦ DIRECT SEXUAL CONTACT ◦ THE EXCHANGE OF BODILY FLUIDS SUCH AS BLOOD, FOR EXAMPLE, CAN BE TRANSMITTED WHEN DRUG USERS SHARE NEEDLES ◦ FROM MOTHER TO CHILD DURING BIRTH OR IN BREAST MILK
TREATMENT & PREVENTION	
• THERE IS NO CURE FOR HIV, ALTHOUGH THE USE OF ANTIRETROVIRAL DRUGS USED EARLY IN THE INFECTION CAN NOW EFFECTIVELY CONTROL THE DISEASE TO SLOW OR HALT THE PROGRESS TO AIDS	

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Influenza virus

- Three different **influenza viruses** infect humans to cause the flu
 - Influenza A, influenza B and influenza C **infect the cells that line the airways**
 - They cause a **high temperature, body aches and fatigue**
 - Influenza A is the virus that causes the most cases of flu globally